


# GRAPHIC SCIENCE

The background of the cover features several thick, parallel diagonal lines in light blue and grey. Scattered across this background are various geometric shapes: large orange rectangles with smaller blue rectangles inside them, solid blue rectangles, and smaller orange rectangles. The overall aesthetic is mid-century modern and minimalist.

DECEMBER 1960

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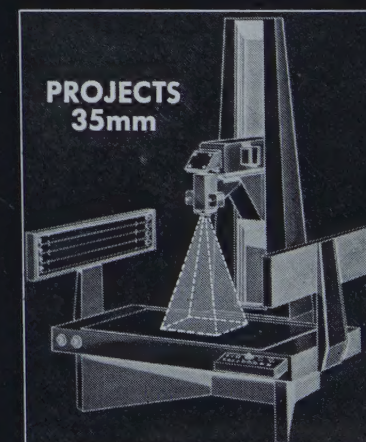
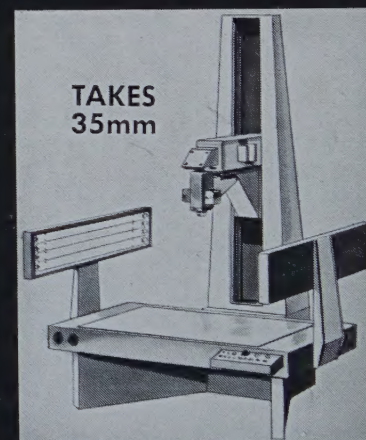
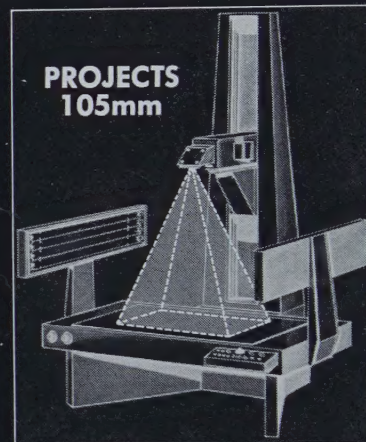
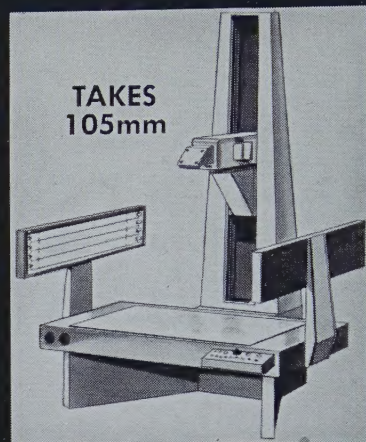
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# GRAPHIC SCIENCE

THIS ISSUE: 12,000 COPIES

DECEMBER 1960

VOLUME 2 NUMBER 12

The Magazine of engineering drawing management, covering drafting, reproduction and microfilming, technical illustration, drawing standards and drawing filing in all industries.

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GRAPHIC PERSPECTIVE

GRAPHIC SCIENCE is published monthly by Kinelow Publishing Company, Inc., Wilton Center, Wilton, Connecticut. (POrter 2-5564). Charles E. Rhine, president; Paul Yake, vice president; David Z. Orlow, secretary-treasurer. GRAPHIC SCIENCE is published (printed) at 116 Main St.,

Norwalk, Conn. Address changes, undeliverable copies, and orders for subscriptions should be sent to Editorial Offices, Wilton Center, Wilton, Connecticut. Postmaster: Form 3579 requested. Subscription rates: \$8.00 per year in the United States; \$9.00 per year to Canada; \$10.00 per

year to other countries. Single copies: \$1.00. ©Kinelow Publishing Company, Inc., 1960. Accepted as controlled circulation publication at Norwalk Conn. Member Business Publications Audit of Circulation, Inc.





## Letters

### The Effect? Zero!

Sirs:

In your October issue you ran a piece by Mr. Earl D. Black of General Motors Institute. The title was "Drafting Know-How," and it stated clearly industry's vital interest in the drafting education of young engineers. Since I am chairman of the Division of Engineering Graphics of the American Society for Engineering Education, you can be sure that I'm deeply concerned about the problem. In fact, Mr. Black made the survey for the specific purpose of reporting it to my Division. But I regret to have to say that this careful report and all the other surveys that have preceded it have been futile and they will almost surely continue to be.

Some years ago I participated in a nation-wide survey of industry's need for draftsmanship on the part of newly graduated engineers. The findings of our committee were identical to those reported by my good friend, Earl Black. We went further. Professor R. S. Paffenbarger of Ohio State University was chairman of the committee that did the work. Paffenbarger gave an oral report before one of the groups meeting at a national meeting of the American Society for Engineering Education—at Cornell University, I think. The effect? Zero! Maybe worse. Paffenbarger's listeners realized that he was a teacher of engineering graphics and, believing he had a personal axe to grind, tended to belittle the efforts of the committee. This leads to a conclusion.

My conclusion is based on that experience plus the discouragement of years of similar failures. Paffenbarger's report and Black's report and all others have failed because the reporters are always suspected of possibly coloring their findings or reporting only what's favorable to their positions. Therefore I'm utterly convinced that teachers are powerless to reverse or even to stay the flow of the tide of diminishing courses and time devoted to engineering graphics. The only influence that might do the job

is the professional engineers' and their personnel directors. If these people will tell the chairmen of the degree granting departments in the engineering colleges that they will not employ young graduates without a reasonable amount of board training, then and only then will graphics have a chance of resuming its vital place. Time is running out.

Failing this kind of intervention from industry, we teachers of engineering graphics in the colleges should bow to the inevitable: we should relax and enjoy ourselves.

IRWIN WLADAVER

Chairman

Division of Engineering Graphics  
Amer. Soc. for Engineering Education

### Uniformity

Sirs:

After reading Mr. Meyers' letter in the October 1960 issue of GRAPHIC SCIENCE, I feel it is necessary to clarify some of his remarks before the wrong conclusions are formed by industry and other government activities. Fortunately, as Mr. Meyers states, he does not speak for the Navy Department, nor does he even speak for the Bureau of Ships. As he states, there are a few who see no real need for complete uniformity in drafting practices. These few, obviously, are those who are concerned only with one activity, one shipyard, or one manufacturer. But even these few insist upon uniformity so that not only the draftsman but also the shop worker are in agreement as to the proper definition of weld symbols, abbreviations, etc. It takes only a few minutes longer to look up the correct symbol or abbreviation than to make one up; but when the drawing must be understood by many, as it must in large scale production, these minutes become insignificant when compared to the confusion and callbacks required because of non-standard data shown on drawings.

Mr. Meyers asks: "How can mono-detail pay off for us?" This leads one to believe that the whipping-boy,

MIL-D-70327, is forcing everyone to a mono-detail system. I would like to call his attention to MIL-STD-7 which allows the use of either mono or multi-detail drawings.

He also writes about the "20 years of 'junk'" that he still needs and cannot afford to redraw. If the drawings had been prepared properly in the first place, handled properly, and used only when the drawing had to be revised, allowing microfilm to take up the brunt of reproduction, Mr. Meyers would have much less of a problem. Often we concern ourselves with the first cost rather than the entire cost over a number of years. The best filming and blow-back techniques are of no value if the original drawing is "junk." It only costs a few cents more to do something right. As the old saying goes: "Do it right or don't do it at all."

Mr. Meyers writes of the Neoflow System adopted by his shipyard. Unfortunately, I have never been able to see this system in operation, since the Neoflow equipment was inoperative due to mechanical difficulties during my last three visits there. Can it be presumed that these "very tangible and large savings" resulting from Neoflow include the cost of repairs and the delays resulting from down-time?

With respect to Mr. Meyers' drum beating for functional drafting, it goes without saying that a certain amount of functional drafting has its place, and does any quick and dirty shortcut. But, is it not the primary purpose of any technical document to transmit information? If so, we should make the drawings easy to be understood by all those who must use them, and not necessarily bend over backward to make it easier for the one person who draws it. If one drawing shortcut results in an error or misunderstanding in production, where is your saving?

Since from the tone of Mr. Meyers' letter he considers himself a critic in the field of engineering drawings it is hard to understand why the Department of Defense is standardizing on

(Continued on page 25)

(Letters to the editor should be addressed to GRAPHIC SCIENCE, Wilton Center, Wilton, Connecticut. Names will be withheld upon request but all must be signed.)





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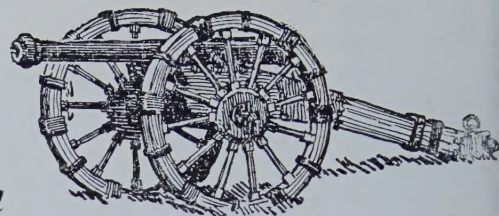
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# Military Engineering Documentation

by W. S. Hutchinson



## Standards in the DoD Program

**S**TANDARDS occupy an important position within the Engineering Documentation framework. We are well aware that military weapons today are more complex than they were twenty years ago; their development, production and maintenance now involve intricate systems. Conventional documentation of engineering data is no longer adequate. The status of technology has changed so drastically in recent years that we are faced now with the compelling task of standardizing basic data inputs into integrated systems.

In addition, one of the most challenging problems today is information retrieval—finding the right data without exhaustive and time-consuming search or having to duplicate the research or design. In the strictly engineering documentation area, the yearly output of engineering drawings alone runs about six million for the military sizes.

The massive files already contain better than 50 million drawings. This excludes the numerous other forms of engineering documentation.<sup>1</sup> It has been estimated that a billion copies of these are reproduced each year to meet defense requirements.

One of the primary objectives of data retrieval systems is to place at the user's disposal an array of processed data representing a higher organization than normally would be available. In this manner, the review and decision-making processes can be

CHART I—ENGINEERING DRAWINGS, ASSOCIATED LISTS AND DRAFTING PRACTICES: STANDARDS

MIL-STD No.	Proj. No.	Title	Prep. Act.	Init. (F. Y.)	Compl. Qtr.)
MIL-STD- 1B	DRPR-0006	General Drawing Practice ...	Sig	1-59	1-61
MIL-STD- 2B		Eng. Drawgs., Sizes & Formats (Consol. of MIL-STDs-2, 3, & 4) .....			Aprvd. 8/25/60
MIL-STD- 7A	DRPR-0033	Types & Defin's of Eng. Drawgs.	Weps	1-60	2-61
MIL-STD- 8C	DRPR-0010	Dimensioning and Tolerancing	OR	2-59	2-61
MIL-STD-12C	DRPR-0012	Abbreviat'ns for Use of Drawgs.	AMC	1-61	4-61
MIL-STD-15B	601-88	Elec. & Electrnc. Symbols ....	SH	3-57	3-62
MIL-STD-16C	DRPR-0024	Elec. & Electrnc. Ref. Designa.	Sig	2-59	2-61
MIL-STD-17A	409-43	Mechanical Symbols .....	SH	1-55	1-61
MIL-STD-19A	DRPR-0030	Welding Symbols (to be superseded by Industry Standard).	SH	1-60	4-60
MIL-STD-24B	DRPR-0016	Revision of Drawings .....	T	4-60	2-61
MIL-STD-28A	DRPR-0019	Drwg. Titles, Apprv. Meth. of Assign. ....	AMC	3-60	2-61
MIL-STD-29	DRPR-0018	Springs, Mach., Drawgs., Reqrmts. for .....	OR	1-61	4-62
MIL-STD-30A		Assoc. Lists, Parts List, Data Lists, Index List .....			Aprvd. 6/1/60
MIL-STD-	DRPR-0004	Lubrication Diagrams .....	OR		Cmpltd. 2/61
MIL-STD-	DRPR-0005	Electrical Schematic Diagrams.	Sig	1-59	4-60
MIL-STD-	DRPR-0023	Optical Diagrams .....	OR	2-59	3-60
MIL-STD-	DRPR-0031	Gears, Drwg. Requirements ..	OR	2-60	2-61
(EP Study)	DRPR-0001	Dept. of Def. Drwg. Practices.	OR		Continuing
(EP Study)	DRPR-0042	Drwg. Nos. & Parts Nos. ....	TC	2-60	1-62
(EP Study)	DRPR-0047	Preparation of Master Formats per MIL-STD-2B .....	SH	1-61	2-61

more complete, more accurate, and much faster. Individual files of a special nature can be eliminated when the user has assurance that the overall system provides better and more accurate service.

As specialization increases, engineers become more informed in their specialties and correspondingly less informed in the surrounding technologies. While their need-to-know has expanded, the organization of data to match that need has not kept pace.

<sup>1</sup> Engineering Documentation consists principally of the following types of documents:

Engineering Drawings  
Associated Lists—  
Parts List (PL) or (ML)  
Data List (DL)  
Index List (IL)  
Technical Manuals  
Technical Orders  
Technical Handbooks  
Specifications  
Standards  
Test and Evaluation Reports  
Data Sheets  
Process and Control Documents, such as—  
Engineering Change Notices  
Engineering Release Notices  
Engineering Orders  
Generation Breakdowns  
Parts Usage Lists

Mr. Hutchinson is Assistant Chief, Mechanical and Engineering Programs Branch, Standardization Division, Armed Forces Supply Support Center, Washington 25, D. C.



The crux of this problem is engineering communication.

Engineering communication, of course, depends principally on the media of engineering drawings, standards, and related data and design criteria. The engineer must have immediate and direct access to this material for his possible application. Adequate systems of engineering documentation will satisfy that requirement.

Once such systems are established, they will remain responsive to the data requirements imposed by both present and future military demands. Maintenance of compatibility between military practices and those of industry will become increasingly important.

We depend on thousands of contractors, sub-contractors, and vendors to design and produce new weapons and supporting material. Each contractor has his own method of operating, and his own practices which differ somewhat from those of other contractors and those of the military services.

CHART I

IT IS ONLY through standards—jointly and cooperatively developed—that these differences can be narrowed. Of the considerable number of Military Standards now in existence, many are currently under revision to bring them in line with newer requirements, such as legibility in reproducing microfilm. New ones are being added. Chart I gives the MIL-STD number where one has been assigned, the project number, title, the preparing activity, and the initiation and expected completion dates by fiscal year quarter.

In the microfilming area, nine documents, Federal and military specifications and standards, were approved back in April 1960, spelling out how data should be furnished in both roll microfilm and utilized PCAM (Punch Card Accounting Machine) aperture card forms. Several of these documents are also under revision to make necessary corrections.

CHART II

OF THE projects relating to documents for procurement of engineering data by the military, Military Specification MIL-D-70327, for "Drawings, Engineering, and Associ-

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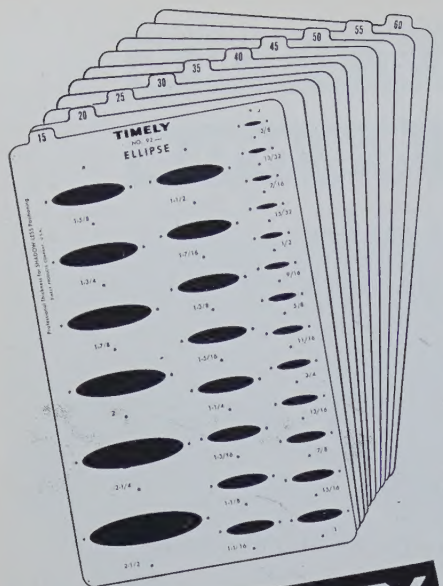
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## CHART II DOCUMENTS FOR PROCUREMENT OF ENGINEERING DATA

Proj. No.	Type Proj.	Title	Prep Act.	Init (FY yr Qtr)	Compl.
DRPR-0039	KP	Armed Services Procurement Regulation Policies Affecting Engineering Documentation . . . . .	AMC	2-60	1-62
MISC-0051	Spec	Procedures, Instructions and Format for the Preparation of Technical Data Sheets (TIF) (based on MIL-D-19731A) . . . . .	AMC	Apprvd	1-59
DRPR-0040	Hdbk	Procedures to be followed by Contractors in Preparing Contractor Design Standards . . . . .	AMC	2-60	1-62
MISC-0077	Stdy	Military/Industry Technical Manual Specifications Standardization Program . . . . .	AFSSC	3-60	
DRPR-0026		Visual Aid for Indoctrination in Support of MIL-D-70327 (Motion Picture) . . . . .	O		Completed
DRPR-0028	Spec	Drawings, Undimensioned, Master Layout . . . . .	AMC	3-60	4-61
	Spec	Drawings, Undimensioned, Printed Wiring . . . . .	AMC		
DRPR-0036	Spec	Drawings, Engineering, and Associated Lists, Rev. to MIL-D-70327 . .	Or	1-60	4-60

ated Lists" was approved a year ago.

An extensive revision is now underway to remove unnecessary options, to clarify requirements, and to provide for more definite identification of the kinds of drawings to be specified for different purposes.

## CHART III

PROJECTS for the preparation of, or revision to, documents furnishing basic design guidance or engineering reference data are Chart III.

## CHART III—DOCUMENTS FOR DESIGN GUIDANCE AND ENGINEERING REFERENCE

Proj. No.	Type Proj.	Title	Prep. Act.	Init. (F.Y.)	Compl. Qtr.)
PRPR-0034	Std	Welding Terms and Definitions (MIL-STD-20 to be superseded by Indus. Std.) . . . . .	SH	2-60	3-61
DRPR-0015		Welded Joint Design, Rev. to MIL-STD-22 . . . . .	SH	3-61	4-62
6650-0004	Std	Optical Terms and Definitions . . . . .	OR	3-58	2-61
DRPR-0035	Std	Definition of Terms for Equipment Division . . . . .	OR	2-60	2-61
DRPR-0017	Hdbk	Sheet Metal Design Details . . . . .	AMC	1-60	4-61
DRPR-0046	Std	Welded Joint Designs, Armored Tank Type (Rev. to MIL-STD-21) . . . . .	OR	1-61	1-62
MISC-0022	Spec	Value Engineering . . . . .	SH	2-59	2-61
MISC-0067	Std	Identification Marking of U.S. Military Property, Rev. to MIL-STD-130 . . . . .	AMC	2-60	2-61
X999-0020	Std	Color Code for Pipe, Hose, and Tube Lines for Missiles and Associated Ground Equipment . . . . .	OR	2-58	4-60
604-008	Std	Color Codes for Gas-Cylinders and Pipelines . . . . .	CML	4-56	2.60
MISC-0055	Hdbk	Micro-Reproduction of Engineering Data, Requirements for Guidance to Draftsmen and Reproduction Personnel (Relates to factors necessary in obtaining satisfactory micro-reproduction of engineering data) . .	AMC	4-59	4-61
701-22	Hdbk	Specifications and Standards, Order of Precedence for Selection of, MIL-STD-143 . . . . .	ARDC	3-58	4-60



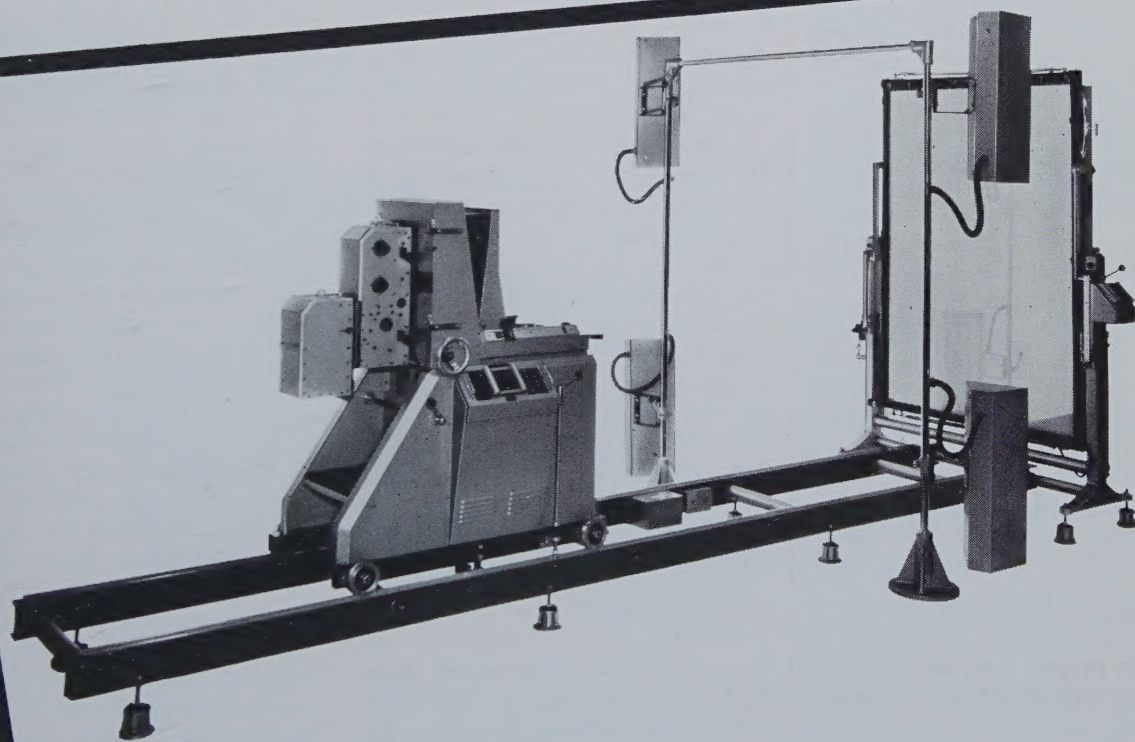
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Wilton, Conn.

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## Award for Service

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The success story of Mr. Cooper and Mr. Trent had its beginning in 1943 when the two men alone started their company at 2521 Wilson Blvd., in Arlington, Va. The firm now has four locations and employs approximately 250 people.

## Pencils

ONE OF the oldest pencil companies in the world, Koh-I-Noor of Bloomsbury, N. J., has announced the establishment of a scholarship at Ferris Institute, a state college at Big Rapids, Mich., where primary emphasis is on practical, vocational and technical education. It will be known as the Koh-I-Noor Pencil Co., Inc., Scholarship, and it will be awarded to the most deserving student in the newly instituted program in Reproduction Technician Training and Drafting. In announcing the scholarship, William E. Danjczek, president of the pencil

company, said, "We are establishing this scholarship at Ferris Institute as a symbol of this company's traditional interest in drafting and engineering, and in encouraging young men to enter the field." The initial award has been granted to Mr. Eugene DeFouw, of Coopersville, Michigan, who entered his first year at Ferris in September.

In addition, Mr. Danjczek has announced a change in his firm's name from Koh-I-Noor Pencil Co., to Koh-I-Noor, Inc. Decision to change the company's name was taken in view of the diversified range of drafting and writing products the firm now manufactures, in addition to pencils and leads.

## Giblin Joins Pack

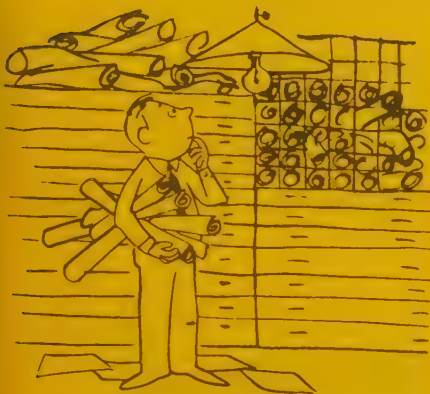
M. R. M. GIBLIN has been named executive vice president and general manager of the Pack Manufacturing Co., Logan, Utah, by the firm's president, Mr. Dean C. Pack. Mr. Giblin, formerly with Hamilton Mfg. Co., Two Rivers, Wis., has predicted a bright future for the Pack enterprise, whose key product is a low cost, interlocking file for storing engineering drawings, tracings and blueprints. According to Mr. Giblin, Pack is currently planning a nation-wide promotion to "tidy-up" the drafting rooms in the design and reproduction departments of America's industries. Means: an independent sales organization now being built. In addition to the Inter Lock Files the firm produces Formliner, a precision device for doing all types of ruling jobs. Additional new products are being developed by the company with market introduction scheduled for mid-1961.

## Ozalid Expands

OZALID Division of General Aniline & Film Corp., is emerging as a major supplier in the whiteprinting industry, according to an announcement from the firm. Twelve new semi-dry diazo machines and an extensive line of semi-dry reproduction materials are now being marketed approximately doubling its product line.



If you have any of these problems:



**Files jammed** and no more space for files (or so it seems)



**Damaged drawings**  
—dog eared, torn, or wrinkled.



**Wasted time** searching for drawings lost, misplaced, or mis-filed.

then you need

# INTER LOCK *Files*



Cone-shaped opening for fingertip removal of drawings

Add individual file tubes horizontally or vertically as needed

Individual indexing on file door

Arrange in any size or shape stack to fit available space

File single rolled drawing, or 3 or 4 individually rolled drawings, or group-roll up to 30 per tube

## SAVE SPACE

Arrange in any size or shape stack to fit existing space . . . extend stacks right to the ceiling or around existing files.

## SAVE TIME

With indexing and out-marking right on file door, drawings are easy to file and find . . . and cone-shaped opening permits fingertip removal.

## SAVE MONEY

Cost is low, and many firms purchase as "office supplies" instead of Capital equipment.

## PROTECT DRAWINGS

Dust-proof, light-tight, crush proof, and fire-resistant construction keeps valuable drawings safe. Easy access protects from handling damage.



© 1960

PACK MANUFACTURING CO.  
P. O. Box 508, Logan, Utah

☐ I am interested in your leasing plan

Please send me more information about the Pack Inter-Lock File system.

Name ..... Title .....

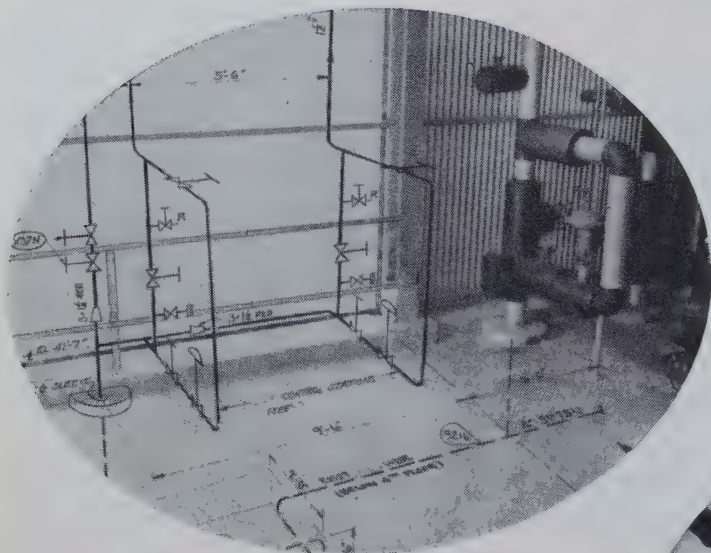
Firm Name .....

Address .....

City ..... Zone ..... State .....



# CRONAFLEX®: best engineering films you can use



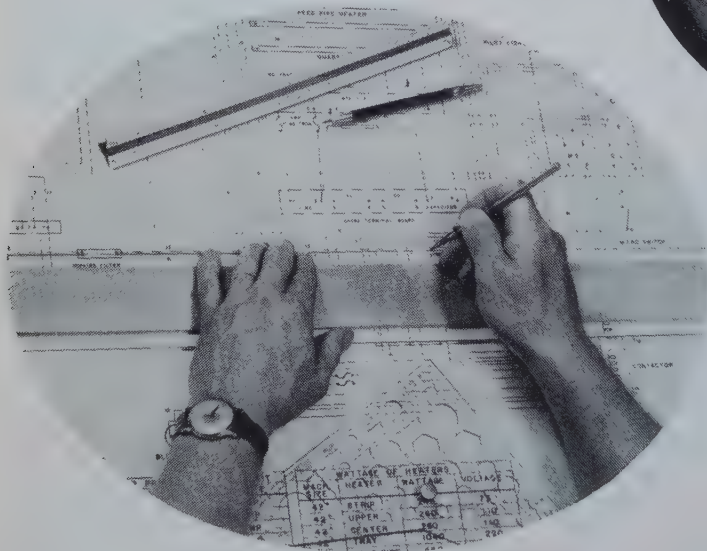
## CRONAFLEX: Photographic versatility

CRONAFLEX plus photography plus drafting equals the best combination for photo-drafting techniques.



## CRONAFLEX: Durability of CRONAR® base

CRONAFLEX copies are free of kinks and tears. Its rugged and flexible base adds years of life to your drawings.



## CRONAFLEX: Superb drafting surface

Matted on both sides, CRONAFLEX accepts pencil and ink, erases easily without ghosting or affecting the surface.



**Better Things for Better Living  
...through Chemistry**

CRONAFLEX Engineering Reproduction Films are now being used to make outstanding reproductions of engineering drawings in shops everywhere. Shown here are three major reasons that help explain its success. There are more.

ALL CRONAFLEX films are on rugged CRONAR\* polyester base. This means they are dimensionally stable... so stable that many companies use them for exacting template work. CRONAFLEX intermediates provide faster print-through speeds and better resolution of detail because of the optical clarity of the base.

CRONAFLEX films are now available in four types: (1) Direct Positive Film; (2) Contact Film; (3) Projection Film; (4) CRONAFLEX Drafting Films. It's the most complete versatile line of engineering reproduction films you can use. For more information, contact your Du Pont Technical Representative, or write: E. I. du Pont de Nemours & Co. (Inc.), Photo Products Department, Wilmington 98, Delaware. In Canada: Du Pont of Canada Limited, Toronto.

\* Du Pont's trademark for its polyester photographic film base.



# *Engineering Documentation: Redstone*

*A report on the microfilming system developed at the U. S. Army Rocket and Guided Missile Agency to handle 2,350,000 engineering drawings and related documents*

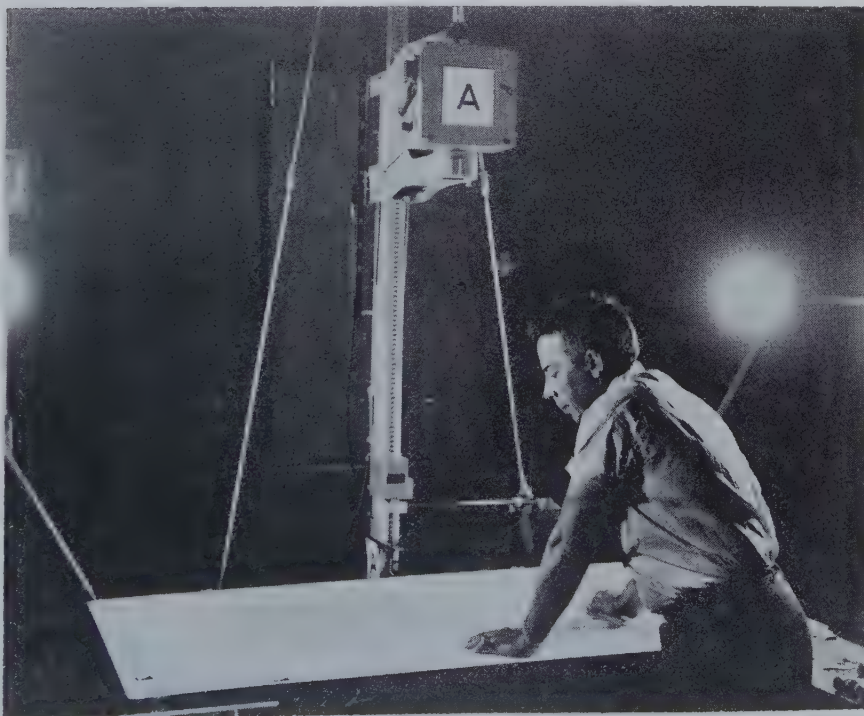
Prepared with the assistance of  
Harry E. Patterson

REDSTONE PHOTOGRAPHER: Ernest MacMeans, Huntsville, Ala.

**D**URING THE PAST three years the United States Army Rocket and Guided Missile Agency (ARGMA), with headquarters at the Redstone Arsenal, Huntsville, Ala., has become one of the largest Defense Department users of microfilm mounted in aperture cards. Currently their engineering documents section contains an active file of over 850,000 drawings and related documents, and they possess a historic file in excess of 1,500,000 drawings and documents, all on microfilm mounted in aperture cards.

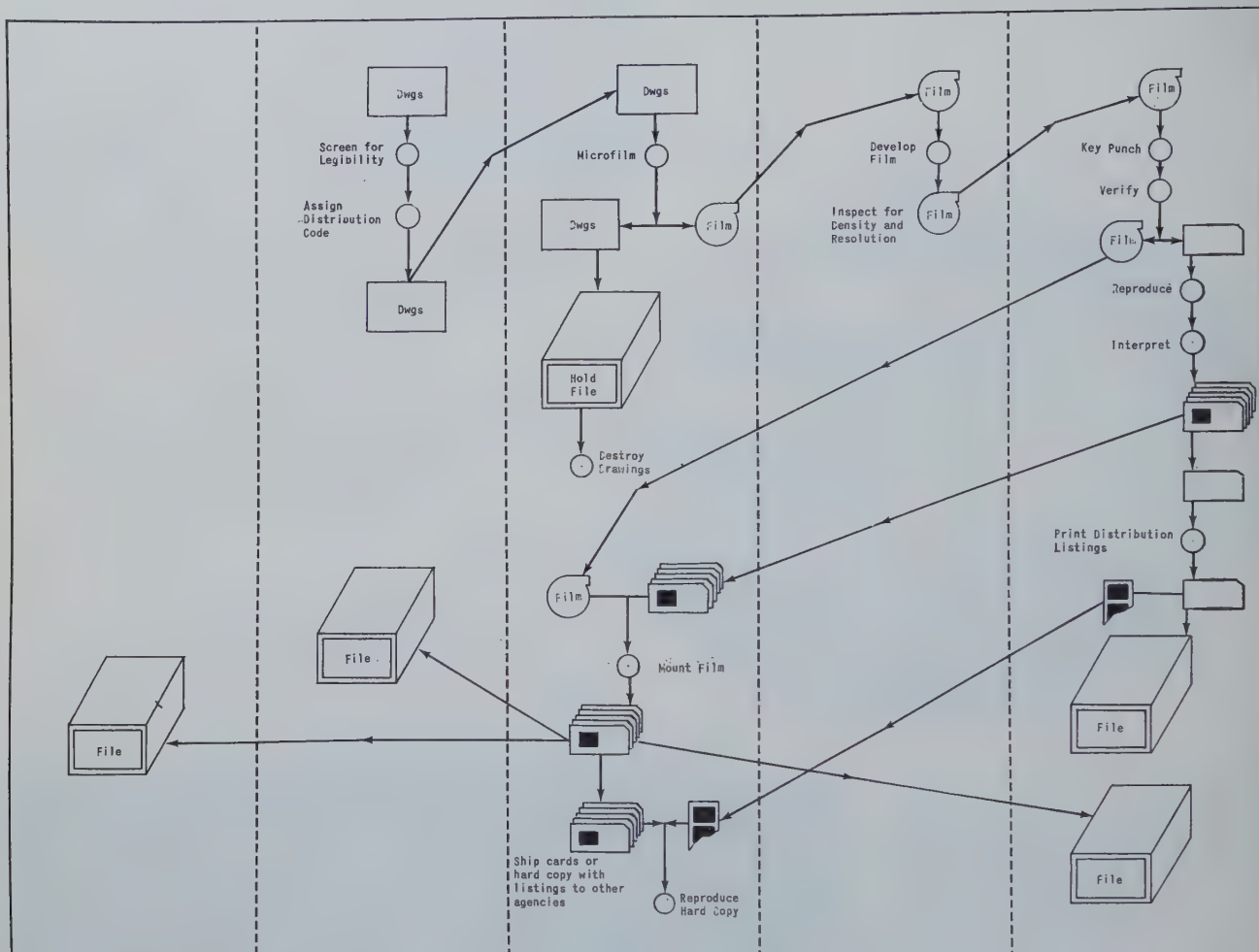
Much of the equipment and many of the procedures are unique to ARGMA and have evolved from specific needs of the Agency, following discussions between Agency personnel and the firms supplying it with the equipment used in the system.

A prime contractor supplying parts and missile weapons is permitted to submit complete engineering records in microfilm mounted in aperture cards to ARGMA (as well as to the



**BASIC CAMERA** is used to microfilm engineering documents originating at ARGMA, and documents and drawings submitted by smaller contractors. 30,000 drawings a month are estimated to pass under the lens of this unit. (Recordak)





## FLOW CHART FOR VISIBLE INDEX CARDS

depots and sub-contractors who will be most directly concerned with the project involved) where this procedure is indicated in the contract. In such a case a prime contractor is not permitted to submit drawings in hard copy.

At present, ARGMA is equipped for instant, completely-mechanical retrieval of any of its 1,500,000 drawings. In addition it can print out in virtually any form desired—paper-to-paper, card-to-paper, card-to-card and paper-to-card. Strategic placement of viewers and reader-

printers throughout the Documentation Service Unit and the engineering section enables personnel to view enlarged microfilm drawings.

Future plans at ARGMA call for even further expansion of the mechanized engineering documentary filing system. Studies are now being conducted on modifications which will permit even more rapid search of filed microfilm documents. The use of closed circuit television to bring the filed documents rapidly to the person desiring to examine them is another possibility which is being studied.

### INCENTIVE FOR PROGRESS

**I**N THE EARLY 1950's, with the very rapid expansion of the Army missile program, it became evident that the then-current method of maintaining engineering records for repairing, maintaining and deployment of weapons would be outstripped.

ARGMA's Engineering Documentation Center was responsible to receive, check, record, store, reproduce and distribute documentation, and relay data, for each component of each missile system: operating units absolutely





**STRICT FILM INSPECTION** is given to each frame or piece sent to Redstone.

had to have proper and up-to-date documentation; engineers constantly referred to and checked drawings; and the procurement division of ARGMA needed quick access to diagrams, drawings and specifications in order to obtain needed repair and replacement parts from manufacturers.

The center began a manual operation in 1950, using original drawings and blue prints. By 1954 it had become apparent that manual operation was far too slow—that some faster, less expensive system of controlling, processing and distributing engineering data was urgently required.

Following two years of intensive feasibility studies of mechanized processing, it was decided in the latter part of 1956 that a combination of microfilm aperture cards and electrical accounting machines would solve many of the problems of the documentation center.

#### SYSTEM DEVELOPMENT

**D**URING THE EARLY months of 1957, two microfilm cameras were procured, the minimum number of electrical accounting machines installed, and ARGMA began converting its engineering documents from a manual to a mechanical filing and retrieval system. During these early months one of the difficulties which had to be overcome was the maintenance of a complete, uninterrupted manual system while the conversion to aperture cards and accounting machines was taking place. For several months the two separate systems had to operate and both files be maintained.

At the beginning all engineering drawings were received by ARGMA

as "hard copy" from the scores of suppliers and contractors. The drawings were checked for accuracy and legibility, microfilmed on 35 mm. microfilm, and then sent to a film processing contractor for developing and the duplication of the desired number of rolls. After this they were returned to the Agency at Redstone. Following this, an EAM (electrical accounting machine) card containing all pertinent information was key-punched and key-verified directly from the roll of microfilm with the aid of a viewer. The keypunched card was then used to reproduce as many duplicate decks as necessary. Through the use of a semi-automatic mounter the roll film was then cut and mounted into the punched card. Simultaneously the operator of the mounter compared the drawing number shown on the film against the drawing number punched in the card as a final check.

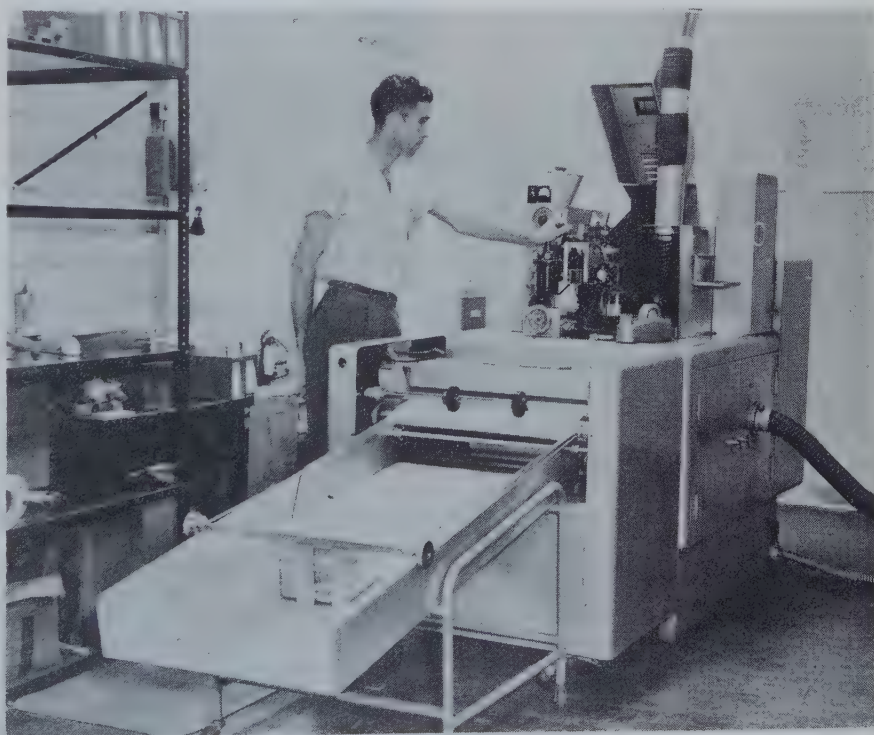
While the system continues basically to operate on the same principle, today because of the increased volume, prime contractors and suppliers submit their engineering data directly on microfilm already mounted into aperture cards. This is done through their contracting officers to ARGMA and other agencies of the Army Ord-

nance Missile Command as well as to specified depots.

ARGMA continues to receive and process hard copy engineering documents from contractors whose work load does not justify the installation of filming, card punching and mounting equipment and whose contracts do not permit this kind of operation. In these cases, as well as for those engineering documents and related data originating at the Agency, ARGMA microfilms, maintains, and provides EAM cards.

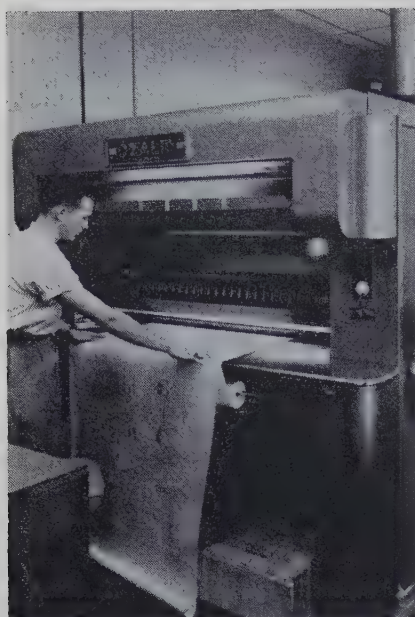
The single great advantage under the microfilm system is that the EAM card, once verified, contains a forever-accurate engineering drawing combination with all pertinent information, ready to be sorted into any desired sequence, reproduced, filed and retrieved with the utmost efficiency by high speed electrical accounting machines. The saving in time is, of course, enormous. Equally important is the space saving. (It is now possible to store 100,000 drawings in only 4 square feet of floor space.) and the saving in personnel (ARGMA has reduced its clerical filing personnel by more than 40% since mechanizing).

In addition, ARGMA has found



**CARD-TO-PAPER** is a frequent printing requirement. Operating at the rate of 20-f.p.m. and cutting each drawing individually, the automatic, continuous electrostatic unit can use either bond or reproducible paper. (Haloid-Xerox)





**PAPER-TO-PAPER** by diazo is not obsolete; it's used at ARGMA to reproduce drawings for needed distribution to any one of a dozen different places. (*Oxalid*)

that there are substantial dollar savings under the new system.

#### SYSTEM ANALYSIS

ONCE MICROFILM had been introduced for the storage of engineering documents, copying became the first subsequent step, since both engineering and procurement needed to have copies of documents available instantly. The Agency therefore set up the following basic methods of printing out any or all engineering information for the use of those agencies concerned.

**I. CARD TO PAPER:** For those needing paper copies in quantity, ARGMA has installed an automatic, continuous electrostatic printer which prints the microfilmed image from aperture cards on either plain bond paper or on reproducible paper at the rate of 20 feet of finished drawings per minute. It is able to print from 1 to 400 copies from any card merely by setting a dial. The machine is equipped with an automatic cutter which clips off each drawing as it leaves the machine. Savings in reproduction costs realized in the first month of use were more than \$53,000; time for reproducing individual drawings was cut by as much as ten days.

**II. CARD TO PAPER:** Automatic microfilm viewing machines, which are relatively low in cost, have been

procured in sufficient numbers for strategic placement throughout the ARGMA Engineering Department. In this way engineers are given the opportunity of rapidly viewing any one of 850,000 drawings with which they might be required to work. If necessary, they can reproduce through this same machine an 18" x 24" paper reproduction of the drawings desired from the aperture card within 10 seconds.

**III. CARD TO CARD:** Since virtually all of the engineering filing and reproduction at ARGMA is on aperture cards, the agency has two types of equipment which print from original card to duplicards. One is a small, manually-fed machine which is used for filling small requests for drawings in film form. The other is an automatic card-to-card printer which will reproduce automatically an average of 600 film cards per hour. All requests for reproduction are filled with duplicates reproduced by these machines, enabling the master file to be kept up-to-date at all times.



**COMPONENT** of card - to - card printer is this specially adjusted automatic developer, eliminating any film development time lag. (*Tecnifax*)

#### IN CONCLUSION

THE FIRST microfilmed engineering drawing of ARGMA's Mechanized Data Processing System was mounted into an EAM aperture card in October 1957. Since that date approximately 7,000,000 microfilmed documents have been completely processed into EAM aperture cards and are in working files on the arsenal or have been furnished the using agencies. The above figure represents approximately 850,000 engineering drawings and related documents.

Engineering documentation sup-

plied on microfilm, mounted in aperture cards, has proved valuable from the point of view of the Agency. Reduction in personnel and equipment, and an increase in efficiency have been achieved. The new policy has not only eased the demands on ARGMA's camera equipment, it has saved appreciably in trans-shipping costs to the agency's fifteen distribution points.

Much of the mechanical equipment now in use at ARGMA was developed by equipment suppliers who stationed personnel at Redstone Arsenal to work out, with ARGMA, adaptations of existing equipment which would do specifically required jobs at the Arsenal.

#### RELATED DATA HANDLING

IN ADDITION to the EAM microfilm aperture card, ARGMA has formulated and put into its mechanized system other EAM punch card projects which tie-in with and control the engineering drawing operation. These projects are designed so that they can be switched from a basic machine operation to a high speed computer operation with minute programming for maintaining accurate engineering records.

One of the most outstanding EAM punch card projects is the Generation Breakdown. This system was devised by ARGMA's Documentation Center Personnel to meet the requirements of handling related data for engineering drawings. This punch card deck is rather simple in design and is furnished by the contractors along with the engineering drawing microfilm card. From this one deck of cards ARGMA has the ability to prepare mechanically:

1. A complete generation breakdown to include nuts, bolts and screws for any Major Item of any given missile or rocket system.
2. Engineering Parts Lists.
3. Engineering Drawing Lists.
4. Engineering Specifications Lists.
5. Parts Usage Lists.
6. Engineering Drawing Number Accountability.

An alphabetical line item number numbering system, not to exceed six positions, has been devised for this generation breakdown system. Through this system approximately





**CARD-TO-VIEWER**, or -paper, is possible with this reader-printer, invaluable in fast scanning of any microfilmed drawing. Hard copy can be made in ten seconds. Units, relatively low in cost, are placed throughout department. (*Minnesota Mining & Mfg.*)

476,000 items for any one major item can be mechanically controlled with the possibility of making approximately 2,000 changes and additions between any two line items of that major item. This system is the only one of its kind known to be in existence and has been thoroughly tested and has proven to be the most effective and efficient method known in mechanically-controlling line item, or assembly, sequence.

The specific objectives of this generation breakdown punch card system are:

1. To mechanize the preparation of an engineering document of parts contained in a major item component, in assembly order, of a given system.
2. To mechanize the preparation of drawing lists.
3. To mechanize the preparation of Specification Lists.
4. To mechanize the preparation of Parts Lists.
5. To provide a mechanized method of inventorying engineering drawings.
6. To provide an aid for standardization of specifications.
7. To expedite and assist procurement.
8. To mechanize the preparation of

used on or next assembly information.

These objectives can be prepared as separate listing or reports, or, all objectives can be listed or reported on one document.



**CARD-TO-CARD** (duplicard) printer is specifically adapted to ARGMA requirements. Geared to duplicate card printing for mass distribution, it handles 600 cards per hour. Agency currently has 15 distribution points. (*Minnesota Mining & Mfg.*)

Another outstanding EAM punch card project designed, formulated and prepared by ARGMA's Packaging Data and Documentation personnel is the Master Index of ARGMA Packaging Data. This index is prepared and published in both Ordnance Part Number Sequence and Federal Stock Number Sequence in EAM punch card decks and in bound book form. It contains the item name, packaging specifications, cleaning method, drying method, preservation type, protective method, unit, intermediate and exterior quantity, weight, and cube plus the Ordnance Part Number and Federal Stock Number. By the development of approximately 50 Packaging Data Standards, this index replaced the requirement for individual Packaging Data Sheets for approximately 75% of the repair part items at a savings of thousands of dollars per year.

### Note

HARRY E. PATTERSON, through whose help this article was prepared, is Chief, Documentation Services Unit, Army Rocket and Guided Missile Agency, Redstone, Alabama. For an overview of this installation, see Mr. William S. Hutchinson's column this month, pages 6-8.—The Editors.



# Reproduction by Diazo

*Denison Engineering evaluates its obsolete equipment,  
then systematically compares new units on the market*

by William E. Baum

**I**MMEDIATE ACCESS, in effect, to any of the thousands of drawings filed in our vaults, or new from the drafting boards, is now afforded engineers, sales and plant personnel and customers of Denison Engineering, through installation of new reproduction equipment,\* which has also sharply reduced labor costs.

Prints made to suit their respective needs are now supplied in half a day as routine, or in minutes if necessary. We have eliminated the expense of 30 to 40 hours a month of reproduction department overtime in the bargain.

This improved service cuts lost working time throughout the company where the lack of a drawing when it's needed is critical—the saving is difficult to place a figure on, but obviously most important.

In addition, we are serving customers (such as the U.S. Navy) faster and more economically by producing the several required originals of a drawing as cloth prints from the master rather than spending draftsmen's time to make tracings.

The demand upon a central reproduction department such as we have reflects the working - against - time nature of our operations. Denison Engineering Division of American Brake Shoe Company employs about 500 people in Columbus, Ohio, in the design and manufacture of Denison "HydrOILic" products—hydraulic sys-

tems. We have six regional offices and sales representatives in principal cities throughout the world.

## THE DENISON ORGANIZATION

**S**OME 65,000 original engineering drawings covering Denison products and applications are maintained in a master file in our vault, under lock and key. The need for reference to drawings by engineering, production, sales, customers and others, must be met by the reproduction of many thousands of copies each week.

These copies include: (A) Black-on-white cloth copies, several per drawing, which are in effect tracings of the master drawings serving as "working originals" to preserve the file masters.

(B) Sepia prints, which are likewise reproducible for wider distribution.

(C) And, blue-line prints of which 40 to 50 copies per drawing may be made for use in sales, engineering, branch offices, service, shop production, inspection and other functions.

An average week sees the reproduction department making some 150 cloth copies, about 400 sepia prints and 8,000-10,000 blue-line copies. In addition to drawings, it will also handle several hundred original items such as schedules, charts, tabulations, etc., that might be requested by sales, accounting, service or other departments needing one to 50 copies.

Our purpose had always been to put print service on its present basis, with half-a-day delivery as routine and exceptional demands met "while-you-wait."

But in the effort to establish this with equipment formerly in use, the reproduction department was forced to overtime consistently, at considerable cost in man-hours and hidden overhead. Fifty hours a month was not unusual.

We believed that the answer to this situation lay in equipment—not the addition of more but in replacement with a new unit of higher capacity.

## ANALYSIS

**S**O, WE sought information on all the diazotype machines available and eventually spread the data on a large chart for comparison of the various whiteprinters most recently on the market.<sup>1</sup>

We recognized that high speed operation depends for one thing on the light source of exposure. Thus, one of the factors on our chart was

<sup>1</sup>A copy of the evaluation chart that Mr. Baum made up is not presently available. However, these are the characteristics that he evaluated in selecting the whiteprinter: Dimensions, Weight, Cylinder Diameter, Type of Delivery (front, rear, both), Electronic Speed Control, Voltage and Amperage Requirements, Output Speed in Feet per Minute, Copy Width, Lamp Wattage, Filtered Air Provisions, Safety Features, General Construction Features, Price, Service Availability, High Volume vs. Low Cost Comparison.


All the major whiteprinting equipment manufacturers were studied, with each make and model listed.—THE EDITORS.

\*Made by Paragon-Revolute Division of Charles Bruning Company.



# MERRY CHRISTMAS AND HAPPY NEW YEAR



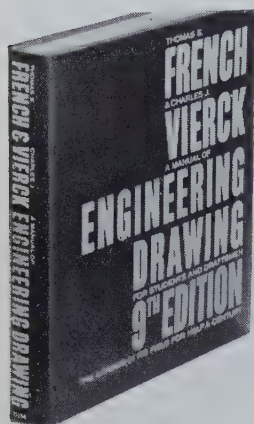
*from everyone at*  
**Ridgway's** 

BRANCHES IN: HOUSTON | AUSTIN | CORPUS CHRISTI | DALLAS | FORT WORTH | NEW ORLEANS  
SHREVEPORT | TULSA | JACKSON | IRVINGTON | DENVER | CHICAGO | NEW YORK | LOS ANGELES  
DEALERS IN ALL PRINCIPAL CITIES



# Win the higher pay of top-flight draftsmen using these proven drawing techniques

There's bigger money waiting for the man with a more complete knowledge of engineering drawing — and you'll have the extra know-how needed to step up your income with the techniques this book makes plain. This best-selling manual—used by thousands of engineers, designers, and draftsmen as an on-the-job reference—covers every vital step in the field of engineering drawing. Its 22 chapters will bring you clear discussions of such subjects as the calculation of volume, the code for materials in section, the effect of basic manufacturing on drawing, and much more.



## Ninth Edition of FRENCH'S A Manual of ENGINEERING DRAWING

By Thomas E. French  
formerly, *The Ohio State University*  
and Charles J. Vierck  
*University of Florida* with the assistance of  
Ralph S. Paffenbarger  
*The Ohio State University*  
9th Edition, 744 pages, 8 1/4 x 9 1/4  
1543 illustrations, \$12.00

With this easy-to-study manual you can fully master the "universal graphical language of the industrial world"—you'll know the *right* way to represent a three-dimensional part, tool, or structure on paper—and be able to do it clearly, accurately, do it so your fellow-workers will know its exact size, make-up, and specifications!

It brings you help right when you need it on the job—gives you all the essential facts on tolerances—explains projection—describes such special methods of drawing as oblique views, sectioning, developments, and pictorial sketching—and finally it provides a detailed study of each class of engineering drawing. Over 1500 illustrations help make this book a "must" for your working library!

### Check these features of the Ninth Edition . . .

- 6 rules for the precedence of lines
- a 6-point system for orthographic reading
- 13-point checklist for tracing drawings
- 2 methods to prepare forging drawings
- 5 steps in preparing auxiliary views
- the 4 types of assembly drawings
- a checklist for structural steel detailing
- a checklist of minimum tolerances
- 5 rules for the calculation of volume
- ASA thread symbols
- 9 point method for making working drawings

To: GRAPHIC SCIENCE,  
103 Park Ave., New York 17, N.Y.  
Please send me . . . . . copies of *A Manual of Engineering Drawing* at \$12.00 each. A check or money order for . . . . . dollars is enclosed.

My mailing address is as follows:  
(print or type)

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

lamp wattage. Similarly, we set down the top-rated speed for each machine in feet-per-minute; capacity in width of prints handled; safety equipment which served to prevent improper operation and to limit any damage to drawings or machine; weight, price and other factors.

Among the most important of these, we put the question of ease and convenience of machine maintenance and the promptness of repair and replacement part service. With so much depending on a steady flow of prints, ruggedness of construction and other machine features that minimize operating troubles and downtime were important things to investigate. The outcome of this survey was the selection of a Revolute Star Whiteprinter, a product of Paragon-Revolute Division. Our needs dictated a 42" model and the highest of three available lamp wattages—150 per inch.

In this machine we now have the means for expertly processing all types of work for maximum speed of production with the requisite print quality in each case.

Experience in the reproduction department shows that we now get this whether the originals are on cloth, paper, or even film. Personnel reading the prints have no need to guess about any fine detail and perhaps make a wrong assumption.

It is now practical to use a lot of sepias, due to the print quality speedily and economically obtained

from them. Sepias are also very suitable to reproduce from when necessary. We are now better able to reproduce old drawings, some of them yellowing with age, especially when the originals are in brown line. Reproductions can be made at a speed of 15 to 20 feet a minute, as against no better than 5 before.

As a consequence of the new printer, engineering, shop production sales, inspection and other functions at Denison Engineering affected in any way by the use of "reproductions," are being facilitated as never before through more rapid production of higher-quality prints.

Backlogs and expensive overtime work in the reproduction department are a thing of the past—to say nothing of the incalculable costs of delay in furnishing engineers, salesmen or other personnel with working tools.

### The Author

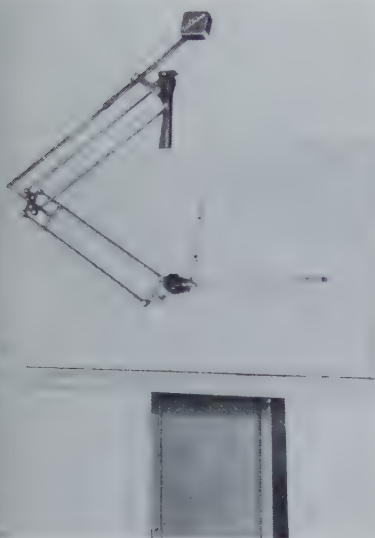
WILLIAM E. BAUM has been supervisor of Engineering Standards for Denison Engineering Division of American Shoe Company for the past four years. Supervising a staff of 125 persons, he is in charge of researching and writing engineering standards and changes for the Denison line of hydraulic system equipment. Prior to this position, Mr. Baum was a field service analyst for North American Aviation, Columbus, Ohio division.



DEMANDS FOR 10,000 or more prints of engineering drawings per week are now met with this one whiteprinter which has eliminated about 10 hours overtime a week



## New Products



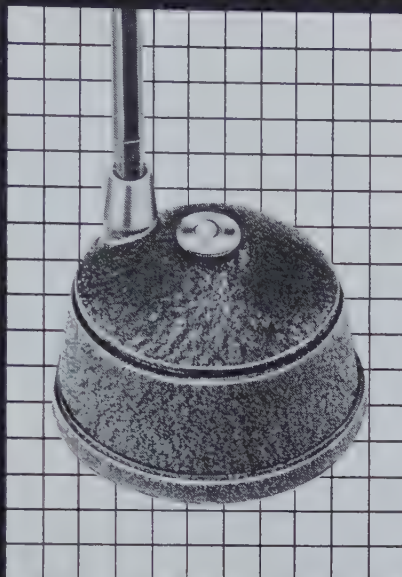
### Column Type Drafting Table

Developed after extensive consumer research, a column type drafting table is now being marketed by Straube Co., Ltd., P. O. Box 358, Oakville, Ont., and Unitech, 50 Colfax Ave., Clifton, N. J. The main characteristics of this new Kuhlmann drafting machine are: (1) Design. It will fit in with any type of office set-up and will harmonize with modern style furniture at a space saving of up to 40 percent. (2) Function. It has finger-tip control in height and angular adjustment. "Floating action" of the board results from counter-balanced arrangement inside the column of the table.

### Plastic-Surfaced Diazo Paper

A sepia-image paper with an unusually long after-life has been announced by Tecnifax Corp., Holyoke, Mass., as especially suited for archival use. It is recommended by the company to users who need permanent files but cannot justify the cost of more expensive materials and methods. The material is recommended for archival use for periods up to 25 years. "New Tecnolith," as the paper is billed, is plastic-surfaced to resist moisture and pilage, and since sensitization is limited to the plastic layer, the 100 percent rag paper base does not become brittle with age.

## FOR A PERFECT POINT EVERY TIME ALWAYS USE *Tru-Point* America's Precision Lead Pointer



Leading draftsmen and engineers find that *Tru-Point* is the perfect lead pointer for many reasons, one of them being its extremely heavy base which enables them to place it directly on the drafting board without need of bolts. There's no need to waste time going to another location. Save valuable time! Get one at your dealer's today. Nearly every dealer has *Tru-Point* available.

Variable Taper Model lets you dial the taper you want:

SHORT   
LONG   
IN-BETWEEN

For Perfect Lead Points — Blunt to Hairline. Two Models

*Standard Model* gives you points up to 1/2" long without breaking. Just insert lead and rotate lid.

*Tru-Point*  
is made exclusively by —

ELWARD MANUFACTURING CO.

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Coloma, Michigan

On December 1  
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is moving to  
the country!

Our  
New  
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Wilton, Conn.

Phone:  
POrter 2-5564



## NEW! *x-acto*® PENKnife

The world famous X-acto knife in a brand new "carry-about" case!

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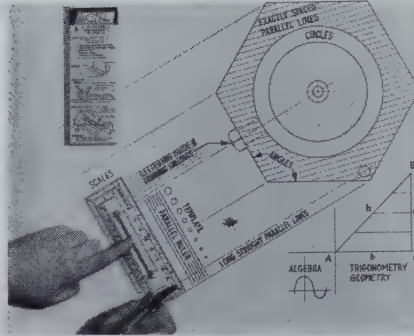
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# New Products

## Adhesive Black Mask

An adhesive-backed, pressure-sensitive black paper designed especially for technical publication masking requirements has been announced by Graphcraft, P. O. Box 509, Westport, Conn. The paper is imprinted in red with a calibrated grid for convenience in measuring and squaring accuracy. Ten- by 13-inch sheet size adequately covers the oversize pages used for MIL-M-005474. Material also has applications in the preparation of charts and graphs, art mechanicals, and photograph masking.



## Drawing Instrument

A new drafting tool, said to perform all of the functions of protractor, compass, ruler, parallels and angles, has been developed by Smith-Drake Corp., 1206 South La Brea, Inglewood, Calif. Called Proco-Rule, the device utilizes a set of gripping wheels assembled in the plastic body to roll, and still hold exact alignment. The 6-by-2-inch rule is made of tinted plastic; scales are integrally molded. All four straightedges are identically bevelled. Sample Proco-Rules may be obtained by sending one dollar (plus 10¢ for handling and postage) to the manufacturer.

## Diazo "Blueprint" Blue

A new, dry process, direct print paper that yields a blueprint blue from negative masters has been announced by Frederick Post Co., 365 N. Avondale Ave., Chicago 90, Ill. The paper has been field-tested, according to company spokesmen, in a number of West Coast plants where "half-size" reproduction programs have been inaugurated. The paper (201M) Diazo Blueprint will provide a wide printing range, and give excellent whiteline detail on a smooth blue background.

## Ellipse Template Set

A "professional" quality series of ten ellipse templates is now being marketed by Timely Products Co., Baltimore, Ohio. The series includes a total of 246 ellipse cutouts from 150° through 60° in increments of 5° from 1/8- through 2 1/2-inches on the major axes. Each template has an extended tab showing the degree of the cutouts it contains. Pinholes for both major and minor axes for centering or locating of each ellipse are indicated. The templates, 6- by 10-inches, are made of tinted Eastman Tenite I plastic. Set retails for \$9.50.

## New Lettering Pencil

A lettering pencil designed for use with the Leroy Scriber has been announced by Keuffel & Esser Co., Third & Adams Sts., Hoboken, N. J. The .020 pencil is designed to produce uniform lines throughout an entire job without repointing. Line width uniformity is attained with a very thin lead, which has the diameter of .020 pencil. Lead can be advanced by turning the pencil in the scriber. Pencil is packaged in a plastic case with lead dispenser and 24 refills. Complete information is available in a four-page illustrated pamphlet obtainable from K&E.

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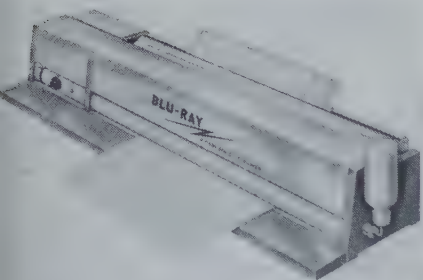
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## New Products



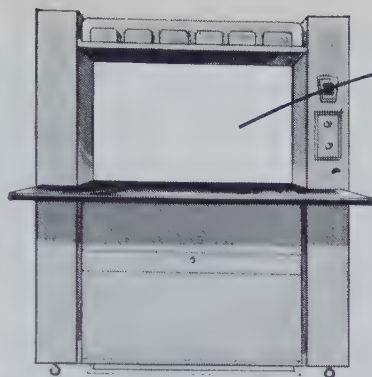
### Dry Diazo Developer

A low cost continuous-action developer of the portable, rotary type has been announced as a companion unit to the Blu-Ray Whiteprinter by Reproduction Engineering Corp., Essex, Conn. The Blu-Ray Diazo Developer will develop prints up to 42" in width (of any length), at variable speeds of from 4" to 72" per minute. Providing faster print developing production than the conventional stack or tube type developers, it does away with the inconvenience of filling ammonia cups. Practically odorless, the developer is charged by tipping up a 16-ounce plastic bottle of ammonia; it tips down to drain. Venting is described as usually not necessary.



### Drafting Table

Modified Deluxe Auto-Shift table, offering a low-position drawing board with a vertical adjustment of 31½" to 40½", has been announced by Hamilton Mfg. Co., Two Rivers, Wis. The low board position, combined with a posture-type chair, is said to provide exceptional working comfort. Vertical adjustment is operated by a foot pedal, and the counterbalanced top can be tilted from 0 to 90° by means of a hand lever release. An L-Contour or Auto-Shift reference desk may be used in conjunction with this model board for "lay down" space.



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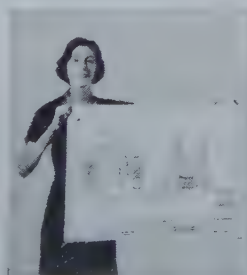
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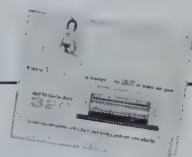
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## The Book Shelf

TECHNICAL ILLUSTRATION (New Edition), by A. D. Pyeatt Higgins Ink Co., Inc., Brooklyn, New York 1960 (\$5.00).

A NEW EDITION of TECHNICAL ILLUSTRATION came across my desk a few days ago and I am delighted with it. I think you will be, too, especially if your work has anything at all to do with pictorial presentation of things technical. Mr. Pyeatt's history in the industry has taught him what the proper proportions are of text and illustrations. His text is amply clear; his illustrations are even clearer. From his teaching experience he knows exactly where student pitfalls are. And from his industrial experience with Douglas Aircraft Company, he knows exactly the kind of quality a professional should produce.

This new book is not going to turn you into a professional technical illustrator. You would need a tremendous amount of practice and study, as in any worth while skill, to do a good job. But what you can get out of Pyeatt's treatise is a very sound, fundamental viewpoint in addition to a mass of authentic and indispensable knowledge. Most of the material, the basic factual material, is available in many scattered places and also in several other books on the same subject. But nowhere have I seen it so concisely set up and so well illustrated.

TECHNICAL ILLUSTRATION is in seven chapters: *Industrial Visual Aids* deals with the history of technical illustration and its functions; technical manual requirements; and industrial visual aids, and other matters. *Perspective Drawing* covers choice of method; basic principles and types; the language of perspective; one-, two-, and three-point defined, explained, and compared; and free-hand sketching. *Axometric Drawing* differentiates and defines isometric, dimetric, and trimetric; and gives industrial uses and advantages of isometric. *Time Savers* does just about what you would expect; one or two items in the chapter might come to your rescue some day. *The Correct Use of Drawing Ink* has some useful information and is not overburdened with too many mentions of Higgins Ink Company. *Rendering Techniques* covers definitions of rendering types, basic principles, tools and materials, line rendering techniques, and full rendering techniques including wash and airbrush. *Technical Manual Illustration* is very full of meat for illustrators and writers of manuals both; it is the longest chapter and very well done indeed.

If you have any interest in these topics, I think you ought to go out of your way to get a copy of the new edition of TECHNICAL ILLUSTRATION. I am sure you will enjoy it and profit by it.

I believe that Higgins Ink Company will welcome your request for more information.

I.W.



## New Literature

**Catalog of Type and Art** printed on acetate (or substitute materials, optional), is being offered by Mico/Type, Inc., 6551 Sunset Blvd., Los Angeles 28, Calif. The catalog, No. 4, is described as containing the largest selection of type faces, symbols, and numbers ever offered on acetate.

**Drafting Table Lamps**, a brochure recently published by Luxo Lamp Corp., Dock St., Port Chester, N. Y., and 1683 Jerrold Ave., San Francisco, Calif., is now available. Lamps, of unusually good design, supply perfect light for detail work, can be tilted or raised or lowered to any position on the board. Request Form 116.

**Catalog of Drawing Instruments**, 124 pages, is described as containing the "most complete line of drawing and measuring instruments and equipment available from any one source," by supplier, Alvin & Co., Inc., Windsor, Conn. Firm describes publication as particularly intended for engineering departments, and other volume purchasers, including dealers, schools, and colleges. The new catalog is free to those who make a written request on letterhead.

**Visual Aids for Drafting Rooms**, a brochure published by the O. A. Olson Mfg. Co., 712 Tenth St., Ames, Iowa, is available on request. The devices described and illustrated are transparent projection boxes and accessories, in both students' and instructors' models, and a wall chart of U. S. standard system of letters and numbers. Price list may also be requested.

**Pencils Catalog**, presenting a broad variety of pencils to suit standard and specialized requirements in drafting room, office, studio, workshop, school and home, has been released by J. S. Staedtler, Inc., 25 Dicarolis Court, Hackensack, N.J. Eighty-one items are shown and described, including a wide selection of professional drafting pencils. Copies are available on request.

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## Letters

(Continued from page 4)

35mm microfilm in lieu of the Neoflow system which in his own words, "results in large savings." Perhaps it is because the Department of Defense looked at the "big picture" instead of drum-beating for a pet project.

In closing, I must add that the opinions expressed here are not only mine, but express the views of the great majority of people who have been faced with illegible, non-standard drawings to be used not just by one activity but several activities. Only by standing back and taking a broad overall look at the entire problem in the Department of Defense can

we fully realize the long term gains evolving as a result of standardization in the drawing field. Value engineering must also take this broad overall look before it can perform its true function. As Mr. W. W. Thomas, of RCA, stated in his article in the September 1960 issue of GRAPHIC SCIENCE: "The transfer of costs out of the drafting department into the shop is no saving. So be sure first, that your cost reduction program is not just a 'cut down on drafting' program."

EDWARD E. MORAVEC  
Department of the Navy  
Bureau of Ships  
Washington 25, D. C.

**Technical Fountain Pen Folder**, (No. K785), describing the non-clogging Rapidograph fountain pen with seven interchangeable drawing point sections, is offered by Koh-I-Noor Pencil Co., Bloomsbury 6, N. J.

**Mechanized Card-finding Brochure** (WSP-18), presenting large and small card-finding units, both mechanized and hand-operated, is offered by WheelDEX & Simpla Products, Inc., 1000 N. Division St., Peekskill, N. Y.





# Graphic Perspective

## The History of Technical Drawing The Technical Professions

“PATIENCE—Courage—Hope” is written on the base of a memorial—one of the oldest—which was erected in 152 B.C. commemorating the building of an aqueduct by the engineer Nonius Datus, to serve the town of Saldea. The structure, one of 21 long-distance ducts built by the Romans to transport water, was just over 13 miles long, and ran through a tunnel 1,404-feet in length. Why all the figures?—and to add a further question, could it have been possible to build these without technical plans? It can be accepted with certainty that many technical drawings were made through which those Roman engineers expressed their ideas!

Who were these men who knew how to build canals, bridges, subterranean channels and aqueducts, siege machines and catapults? Today we admire these antique buildings. Could they have been possible without the assistance of experienced

technicians possessed by patience, courage and hope? We put technique side-by-side with art today but forget that art and handicraft, especially the occupation of metal workers was described by the Greek word *techne* in songs by Homer. Those who practiced it were called, in Greek, *technites*.

The Romans classified under the description “architecture” anything that was built, including cities, streets, buildings, machines, mills, lifting gear, organs, pumps, war machines, etc. The training of the *architectus* can well be compared with that of the engineer in our times who has been academically educated, for we read in the most important collective work in Roman literature: *The Architectura* by Vitruv (circa 35 B.C.) about the essence of *architectura* and the education of the architect:

Theory and practice must go hand in hand. The *architectus* must be talented as well as willing to learn. He must be stylistic, versed in drawing, schooled in geometry, not ignorant in the laws of optics and arithmetic. He must know history, be acquainted with the philosophers and also understand music. He must not be ignorant of the art of healing and must be familiar with the decisions of lawyers. He must know astronomy.

Vitruv stresses that the *architectus* must be an ingenious inventor.

Men of such many-sided education bore great responsibility under Roman administration, particularly under the dictators, who used the builders’ skills only too willingly to increase their own fame. Emperor Tiberius, a melancholy and suspicious dictator, condemned builders of machines and their helpers to fights with gladiators when a machine, scaffold or some other construction did not turn out right (around 30 A.D.). Roman Emperor Alexander Severus founded around 228 A.D. a technical school where mechanics and engineers (*architecti*) could be trained among members of other learned professions. The sons of poor but free parents who attended this school received free corn from the state. Approximately 60 years later the Emperor Diocletian enforced a tax in order to pay the fees of teachers of architecture.

Training for the *architectus* demanded a high standard of education as can be seen by an order of the Eastern Roman Emperor, Constantin I, dating from 334, in which he instructs the governors of Africa to persuade persons of about 18-years of age who were already versed in all the sciences to train for the position of *architectus*.

This is the first part of Chapter II of an authoritative and beautiful book, **THE HISTORY OF TECHNICAL DRAWING**, by Franz Maria Feldhaus published in 1959 by Franz Kuhlmann, K.G., of Wilhelmshaven, Germany as **GESCHICHTE DES TECHNISCHEN ZEICHNENS**. We are indebted to the publisher for the translation, as well as for permission to republish this fascinating work. It will be continued in this department from month to month, until completed.—The Editors.

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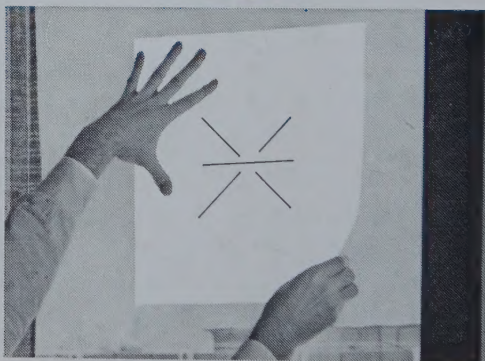
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